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DEPARTMENT OF COMMERCE

National Institute of Standards and Technology

Deprecation of the United States (U.S.) Survey Foot

AGENCY: The National Institute of Standards and Technology and the National Geodetic Survey (NGS), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), Department of Commerce (DOC)

ACTION: Notice; request for comment.

SUMMARY: The National Institute of Standards and Technology (NIST) and the National Geodetic Survey (NGS), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), are taking collaborative action to provide national uniformity in the measurement of length. This notice announces a decision to deprecate the use of the “U.S. survey foot” on December 31, 2022. After that date, the “U.S. survey foot” will be superseded by the “foot” (formerly known as the “international foot”), which is already in use throughout the U.S. This notice describes the plan, resources, training, and other activities of NIST and NOAA that will assist those affected by this transition, and invites comments and other information from land surveyors, engineers, Federal, State and local government officials, businesses, and any other member of the public engaged in or affected by surveying and mapping operations.

DATES: Comments and other information must be received by [INSERT DATE 45 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER*].

ADDRESSES: NIST and NOAA are using the <https://www.regulations.gov> system for the submission and posting of public comments in this proceeding. All comments in response to this

notice are therefore to be submitted electronically through <https://www.regulations.gov>, via the web form accessed by following the “Submit a Formal Comment” link near the top right of the *Federal Register* webpage for this notice.

FOR FURTHER INFORMATION CONTACT:

U.S. survey foot deprecation resources: <https://www.nist.gov/pml/us-surveyfoot>.

Information on standards development and maintenance: Elizabeth Gentry, 301-975-3690, Elizabeth.Gentry@nist.gov.

Technical and historical information on usage of the foot: Michael Dennis, 240-533-9611, Michael.Dennis@noaa.gov.

SUPPLEMENTARY INFORMATION:

BACKGROUND: This action is designed to establish national uniformity in length measurements based on the foot. For more than sixty years, two nearly identical definitions of the foot have been in use in the U.S. for geodetic and land surveys. A *Federal Register* notice published on July 1, 1959 (24 FR 5348) by the National Bureau of Standards (renamed the National Institute of Standards and Technology in 1988) and the U.S. Coast and Geodetic Survey (reorganized as the National Geodetic Survey under the National Oceanic and Atmospheric Administration in 1970) refined the definition of the yard in terms of the International System of Units (SI), commonly known as the metric system. The 1959 notice was issued after an international agreement among six nations resolved a long-standing difference in the relationship of the U.S. yard to the British yard. The notice reported that there was a slight difference (2 parts per million) between the 1959 definition (i.e., one yard = 0.914 4 meter, exactly) and an 1893 definition (i.e., 1 yard = 3600/3937 meter, or approximately 0.914 401 83 meter).

The 1959 *Federal Register* notice then adopted a revised value for the foot for use throughout the U.S., and identified it as the “international foot” to show that it corresponded with the foot in use by the United Kingdom and other countries. The notice defined this international foot as 0.304 8 meter (e.g., equal to 0.999 999 8 of the value for the foot officially adopted in 1893). Additionally, to avoid disrupting the surveying practices at the time, the notice established an interim approach that permitted the limited use of the historic 1893 value of the foot exclusively

in the field of geodetic surveys. It was identified as the “U.S. survey foot” with the defined value of 0.304 800 61 meter (approximately). The 1959 notice specifically stated that the “U.S. survey foot” should be used “until such a time as it becomes desirable and expedient to readjust the basic geodetic survey networks in the United States, after which the ratio of a yard, equal to 0.914 4 meter, shall apply.”

As announced in a *Federal Register* notice published on March 24, 1977 (42 FR 15943), NOAA officially adopted the meter as the unit for length in the National Spatial Reference System (NSRS). However, U.S. surveying and mapping practitioners continued to use the “U.S. survey foot,” including when they employed the NGS-defined State Plane Coordinates System of 1927 and 1983 (SPCS 27 and SPCS 83, respectively). Because the “international foot” is the basis for all other length measurements and calibrations in the U.S., it is no longer necessary to continue to maintain two unit values for the foot.

CONSEQUENCES FOR SURVEYING, MAPPING, AND ENGINEERING IN THE UNITED STATES:

Although the use of the “U.S. survey foot” was intended to be an interim measure, its use continues to be prevalent in land surveying and mapping in much of the U.S. Of the 50 U.S. jurisdictions that have legislated SPCS 83 (48 States plus Puerto Rico and Guam), the “U.S. survey foot” has been specified for SPCS 83 in 40 States, either through statute (28 States) or *Federal Register* notices (12 States). Six States have adopted the “international foot” for SPCS 83, while two States (plus Puerto Rico and Guam) have not formally designated the type of foot to be used. It is important to note that State legislation and *Federal Register* notices regarding the “U.S. survey foot” are specifically associated with SPCS 83, and therefore are not applicable to the NSRS Modernization in 2022.

It is also important to note that while the difference between the two definitions is 2 parts per million, this small discrepancy accumulates over large distances and can result in significant errors in surveying and civil engineering projects, regardless of the size of the project. For example, when a one-mile distance is surveyed, the difference is approximately 0.01 ft or 0.12 in. However, the impact becomes substantial when longer distance measurements or conversions

are made, such as those involving rectangular plane coordinates of SPCS 83. In these cases, the difference between the two definitions can also result in large direction and position location errors, in many cases reaching tens of feet for SPCS 83 coordinates.

Because of this situation, there has been a long history of misunderstandings and confusion over which definition of the foot was used to carry out a specific land survey or civil engineering project. There have been many instances where software or electronic surveying devices default to one or the other foot definitions, but users incorrectly assume the actual unit of measure in use. This ongoing ambiguity has resulted in professional liability by the inadvertent violation of State law, the introduction of systematic errors in surveying and engineering projects, misreported position and location, land sale and project delays, boundary disputes, additional costs associated with correcting unit mistakes, and other unintended consequences. Because State jurisdictions with different legal definitions of the foot share borders, mapping projects in these geographic zones may experience elevated error risks as a surveyor transitions between a State that uses the “U.S. survey foot” and a State that uses the “international foot.” This risk is exacerbated when professional surveyors and engineers are licensed to practice in multiple States that use different versions of the foot, and for large projects when the team participants come from different States and even different countries. In addition to the cost due to errors, there is the cost of inefficiency, since it is necessary to keep track of the foot version, which increases with the size, duration, and complexity of projects.

OPPORTUNITY TO ELIMINATE CONFUSION:

Since the publication of the 1959 *Federal Register* notice, experience has overwhelmingly revealed that national uniformity cannot be ensured in this critical industry field when users are routinely confronted with two definitions of the foot. The best opportunity for eliminating the redundancy in values for the foot will occur with the NOAA program to modernize the NSRS in 2022.

The only practical solution is to deprecate the “U.S. survey foot” and to require that its use in surveying, mapping, and engineering be discontinued. Allowing the continued use of two definitions of the foot undercuts the value and benefit of national uniformity, and allows for

additional opportunities for confusion and unnecessary costs to the users, the States, and professionals in the surveying, mapping, and engineering fields. No compelling justification to maintain two definitions for the foot exists.

NOTICE FROM THE DIRECTOR OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY REGARDING THE DEPRECATION OF THE “U.S. SURVEY FOOT” ON DECEMBER 31, 2022.

Under Article 1, Section 8 of the United States Constitution, Congress retains the power to “fix the Standard of Weights and Measures.” Throughout that section, the words “uniform throughout the United States” are used in conjunction with many of the other duties and responsibilities that are listed. The “fixing” or defining the standards of weights and measures is intrinsic to ensure uniform measurement across the U.S., as well as with the rest of the world. In 1866, Congress acted to make the metric system of measurement (now known as the International System of Units (SI)) legal for use in the United States (15 U.S.C. 204). On May 20, 1875 the U.S. signed the Meter Convention (known as the “International Treaty of the Meter”), which established the International Bureau of Weights and Measures, an intergovernmental organization under the General Conference on Weights and Measures that oversees the International Committee for Weights and Measures, which is the organization that maintains the SI to meet the measurement needs of the world. On April 5, 1893, the “Mendenhall Order,” issued by the U.S. Coast and Geodetic Survey with the approval of the U.S. Secretary of the Treasury, determined that the U.S. Customary units of the yard and pound would be defined in terms of the SI units of the meter and kilogram. The practice of defining the U.S. Customary units of measurement in terms of the SI continues today.

In 1988, Congress declared that the metric system was the preferred system of measurement for trade and commerce in the United States (15 U.S.C. § 205b). The Director of the National Institute of Standards and Technology is authorized by statute “to develop, maintain, and retain custody of the national standards of measurement, and provide the means and methods for making measurements consistent with those standards” (15 U.S.C. 272(b)(2)), “to assure the compatibility of United States national measurement standards with those of other nations” (15

U.S.C. 272(b)(9)), and to “cooperate with the States in securing uniformity in weights and measures laws” (15 U.S.C. 272(c)(4)). Under this authority, the SI is interpreted or modified by the Director of NIST for use in the United States. The SI is used exclusively to define, establish, and maintain the U.S. national standards of measurement and in securing uniformity of their use in the laws of the States.

“Deprecation” is a term widely used in the field of legal metrology and other measurement science fields of study. It describes a decision to discontinue the use of a specific measurement unit or method of sale. A unit of measurement (e.g., the foot or gallon) though legal, may be prohibited from being used in a specific commercial application if, for example, it has been identified as being redundant or a source of confusion, or if it could frustrate the ability of users to make quantity and value comparisons. For example, gasoline and other engine fuels are permitted to be sold from a retail service station by the gallon but may not be sold by the fluid pint or fluid ounce. As the situation with multiple definitions for the foot illustrates, measurement unit uniformity is only possible when a single measurement unit definition is used for a specific application (e.g., land surveying).

The deprecation process begins with a notice to users that a unit of measure is to be deprecated and that use of the unit is to be avoided after a specific date. The notice also prescribes the new unit of measurement that will be accepted for use. The notice period allows users time to make the necessary changes to their measuring practices, processes, procedures, and devices. The notice period also provides an opportunity for education and training for all of those involved in the changeover and the identification of unforeseen issues so that appropriate preventive actions, exceptions, or additional requirements can be developed and implemented. After the notice period ends, the deprecated measurement unit is deemed obsolete, its use is to be avoided, and it is retained for historical purposes and legacy applications only.

DEPRECATION OF THE SURVEY FOOT, SURVEY MILE, AND OTHER MEASURES DERIVED FROM THE SURVEY FOOT

On December 31, 2022, the 1893 “U.S. survey foot,” as defined in a 1959 *Federal Register* notice (24 FR 5348, June 30, 1959), will be deprecated as a U.S. national standard of measurement and its use is to be avoided. The 1893 definition of the “U.S. survey foot” will be retained for historic reference but will be deemed obsolete. This notice also applies to the “U.S. survey mile” (equal to approximately 1609.347 meters), which is based on the “U.S. survey foot,” the use of which should also be avoided after December 31, 2022 and which will be retained for historical purposes but will be deemed obsolete. After December 31, 2022, any data derived from or published as a result of surveying, mapping, or any other activity within the U.S. that is expressed in terms of feet shall only be based on the “foot” equal to 0.304 8 meter (exactly), formerly known as the “international foot” in the 1959 *Federal Register* notice.

Likewise, other measures previously based only on the “U.S. survey foot” will be defined using the foot equal to 0.304 8 meter (exactly) after December 31, 2022. These measures are the “chain,” “link,” “rod” (also “pole” or “perch”), “furlong,” and “fathom” for length, and the “acre” for area. Decimal SI equivalents for these measures are given in Table 1 for both the “U.S. survey foot” (approximate) and the “foot” (exact). For these measures, the difference between the two types of feet is usually of no practical consequence. For example, the greatest precision typically used for the chain in modern land surveying practice is three decimal places (or 0.1 link), and at that level of significance both versions of the foot give the same value. Similarly, the difference in area for 1 acre is only 0.000 004 acre (0.17 ft²) for the two foot versions.

Table 1. Approximate decimal SI equivalents for measures commonly given in “U.S. survey feet” and exact equivalents for the “foot” that will be adopted after December 31, 2022 in NIST SP 811, *The NIST Guide for the use of the International System of Units*.

Unit of measure based on feet	Type of quantity	“U.S. survey foot” (approximate)	“foot” (exact)
foot (ft)	length	0.304 800 6... m	0.304 8 m
mile (mi)	length	1609.347... m	1609.344 m
chain (ch)	length	20.116 84... m	20.116 8 m
link (li)	length	0.201 168 4... m	0.201 168 m
rod (rd), pole, perch	length	5.029 21... m	5.029 2 m

furlong (fur)	length	201.168 4... m	201.168 m
fathom	length	1.828 804... m	1.828 8 m
acre (ac)	area	4046.872 609 9... m ²	4046.856 422 4 m ²

In keeping with the terms of this notice, the “U.S. survey foot” will no longer be supported by NOAA in the modernized NSRS after 2022, including the State Plane Coordinate System of 2022 (SPCS2022), elevations, and all other components of the system. However, the “U.S. survey foot” will be permanently maintained in NOAA products and services for legacy applications, for example the computation of SPCS coordinates in States where it was specified for SPCS 83, and for all zones of SPCS 27.

COMMENTS AND FUTURE ACTION

The Director of NIST and the Director of the National Geodetic Survey (NGS) solicit comments and suggestions from land surveyors, engineers, Federal, State and local officials, equipment manufacturers, and the public at large who are engaged in or affected by surveying and mapping operations for ways that the two agencies can help facilitate an orderly transition to a single definition for the foot. Throughout the notice period, NGS and the NIST Office of Weights and Measures will work together to provide opportunities for education and training for all of those involved in the changeover. After the public comments are evaluated, any unforeseen issues identified, and appropriate solutions developed, a second *Federal Register* notice addressing those issues will be published and publicly announced in other media as appropriate before June 30, 2020.

This action is being taken in conjunction with the NGS program to improve the National Spatial Reference System (NSRS), as described at <https://geodesy.noaa.gov/datums/newdatums/index.shtml>. In 2022, NGS will replace the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD 88) with new geometric reference frames and a geopotential datum. The new reference frames and datum will rely primarily on Global Navigation Satellite Systems (GNSS), such as the Global Positioning System (GPS), as well as on a gravimetric geoid model resulting from the

NGS Gravity for the Redefinition of the American Vertical Datum (GRAV-D) Project. These new reference frames and datum will be easier to access and maintain than NAD 83 and NAVD 88, which rely on physical survey marks that deteriorate over time.

On April 18, 2018, NGS issued a draft *Federal Register* notice (83 FR 17149) for public comment on draft policy and procedures for the State Plane Coordinate System of 2022 (SPCS2022), which will be referenced to the 2022 reference frames. In those draft documents, it was specified that SPCS2022 parameters will be exclusively defined using metric (SI) values. However, in addition to metric values, the documents stated that output coordinates could also optionally be provided in either “international” or “U.S. survey feet,” and that by default the type of foot would be the same as currently used for SPCS 83. The official version of SPCS2022 Policy, effective April 23, 2019 (https://geodesy.noaa.gov/INFO/Policy/files/SPCS2022_Policy_NGS_2019-1214-01.pdf), states that NGS has not yet determined whether or what type of foot will be supported for output coordinates (Section II.E.1). The policy will be updated after NIST and NOAA co-issue a *Federal Register* notice by June 30, 2020, announcing adoption of the “foot” equal to 0.304 8 meter (exactly) as the official definition for all applications in the U.S. after December 31, 2022.

Kevin A. Kimball,
Chief of Staff.

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